THE WEATHER AND CIRCULATION OF NOVEMBER 1965

A Warm Month With Record Rain in the Southwest

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1. HIGHLIGHTS

This was one of the warmest Novembers on record from the Southern Plains northwestward across the central Rockies. At Oklahoma City it was the warmest November (average temperature 56.3° F.) in 76 years, and at Grand Junction, Colo., the warmest (48.3° F.) since 1892. On November 2, 77° F. was reported at Sheridan, Wyo., equaling the record for the month.

Record rainfall for November fell in southern California, where over 8 in. was reported in most coastal areas, resulting in flooding, mudslides, and considerable damage. Los Angeles received 9.68 in., over eight times the normal amount, and adjacent areas of Nevada and Arizona received over six times the normal amount. Record cloudiness was also a feature of the month in that region, ranging from 14 and 15 days in California to 19 days in Arizona. Rainy days also occurred in near record numbers at Fresno, Calif. (10), and at Olympia, Wash. (26).

In the Mid-Atlantic States and southern New England the great drought of the last four years was aggravated by one of the driest Novembers on record. In the District of Columbia, it was the driest November (0.37 in.) since 1871, and at Boston, Mass., subnormal rainfall helped make 1965 thus far the driest such period in 148 years.

2. THE MONTHLY CIRCULATION

The average circulation at 700 mb. in November 1965 (fig. 1) consisted of deep troughs off the coasts of the continents, much farther east than the usual locations. Over North America, for example, the November trough is usually located near the Upper Great Lakes region [1]. This abnormal eastward shift was linked to the shortened planetary wave spacing produced by an additional trough in the eastern Pacific, not usually observed in the November circulation [1]. This trough continued the steady eastward shift toward the west coast of North America that began in late summer.

Blocking developed strongly during the month near Greenland and near Alaska where positive height anomaly centers of 550 ft. and 460 ft., respectively, were observed (fig. 2). The Greenland block apparently retrograded from its October location over Europe [2], while the Pacific block resulted from amplification of the strong but flat October ridge in the central Pacific.

The height change pattern at 700 mb. from October to November, relative to normal (not shown), was quite similar to the height anomaly pattern (fig. 2) in most regions. Strong rises in the Pacific and Greenland ridges were accompanied by strong height falls to the southeast of them. This resulted in heights that were more than 300 ft. below normal off the west coast of North America and in western Europe, where there was abnormal storminess.

In the Western Pacific a deep storm center was observed near Kamchatka with mean heights as much as 500 ft. below normal. To the south of the northern Pacific block, heights were generally below normal in the subtropical mid-Pacific, manifested by unusually active disturbances in that region.

The height anomaly center near Maine (−180 ft.) and the average storminess it reflected were quite weak considering the apparent advection of vorticity from the deep storm center off the west coast and the effects of the strong Greenland block. This slight activity was probably associated with the failure of the Greenland block to merge with the North American ridge. Instead, the geostrophic flow relative to normal over northern Canada (implied by the height departure contours in fig. 2) was easterly and strong while the flow over the United States was westerly and also stronger than normal. This resulted in even less than the normal interchange between high and low latitudes and consequently less baroclinic development.

The principal jet axis (fig. 3) was north of normal over most of the Pacific but in the eastern part it was south of normal in the deep trough there. Over the United States the jet was more westerly than normal, while in Europe it was far south of normal reflecting the influence of the strong block over Greenland.

3. TEMPERATURE

Considerable warming occurred in November, relative to normal, from the cool weather in the East and South in October [2]. At Birmingham, Ala., for example, temperatures were above normal for the first time since April.

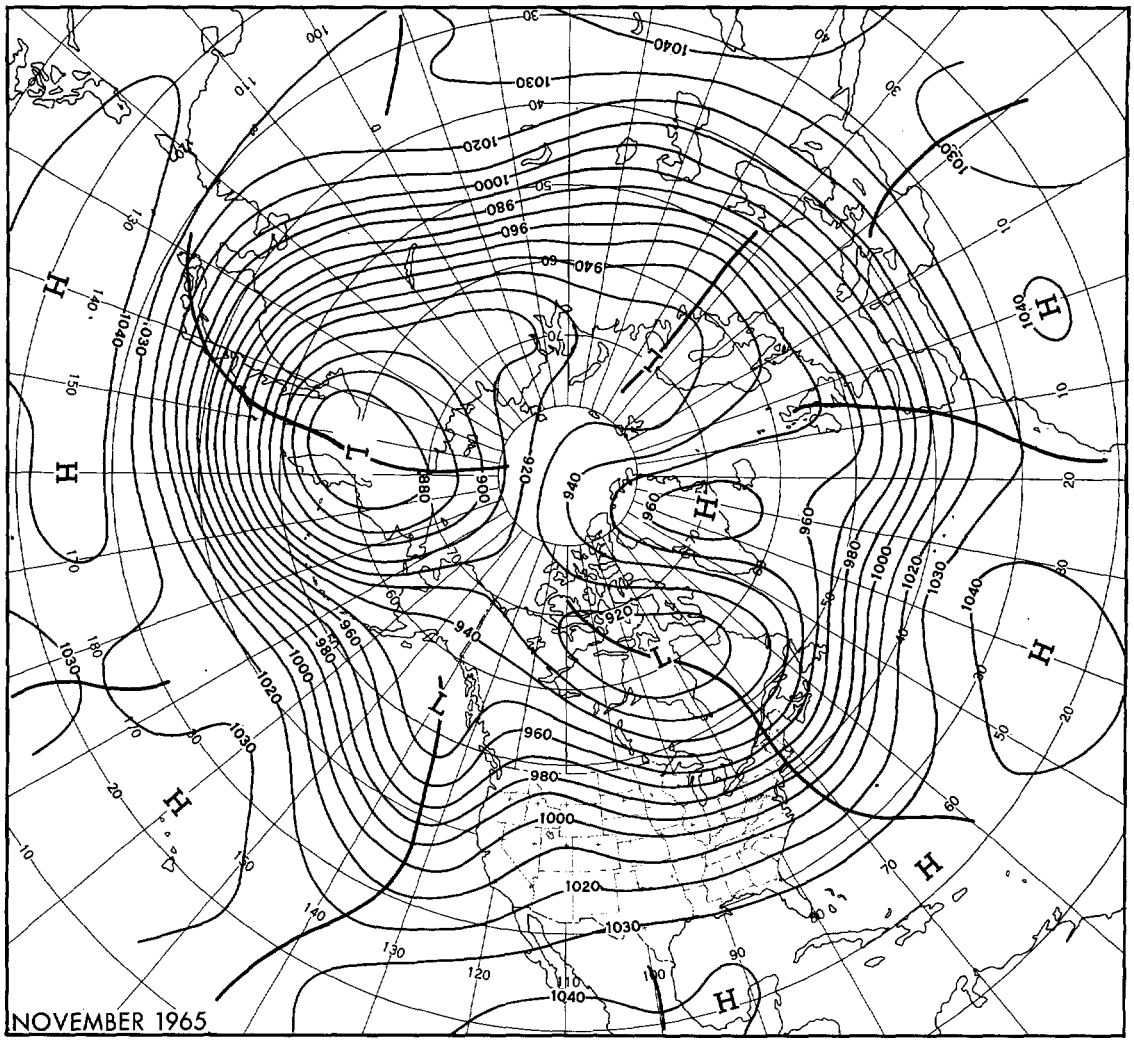


FIGURE 1.—Mean 700-mb. contours (tens of feet), November 1965.

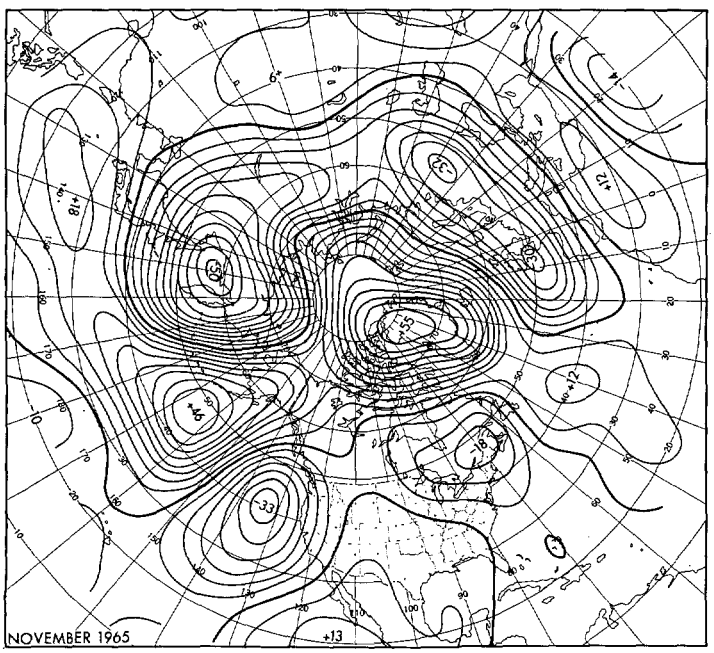


FIGURE 2.—Departure of mean 700-mb. heights from normal (tens of feet), November 1965.

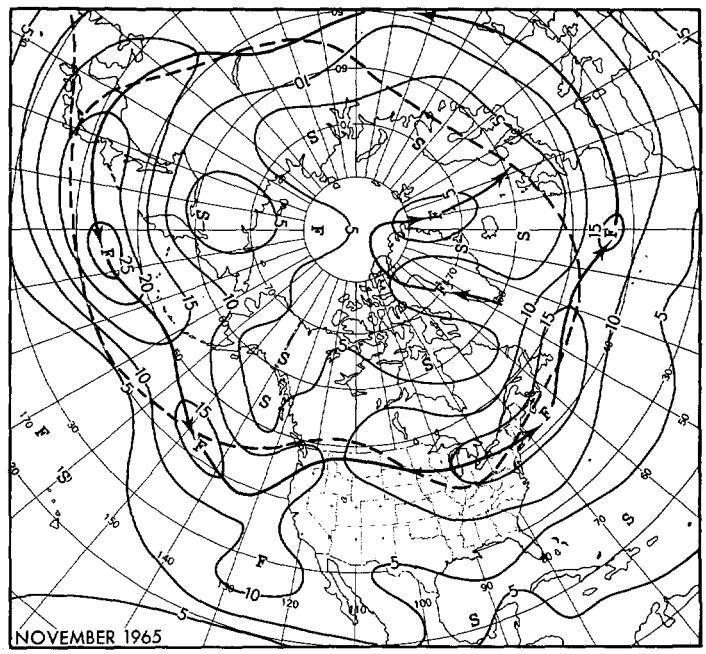


FIGURE 3.—Mean 700-mb. isotachs (meters per second), November 1965. Solid arrows are principal axes of maximum wind speed, and dashed lines are the normal.

This was a result of the change from the predominantly northerly flow east of the Rockies in October to stronger than normal and flatter westerly flow in November. From the Pacific Northwest across the Central and Southern Plains to the Mississippi River (fig. 4) temperatures averaged in the "much above" category, amounting to as much as 9.6° F. above normal at Salt Lake City, Utah, and 9.4° F. at Abilene, Tex. This was a result of the persistence of anticyclonic westerly flow which originated at lower latitudes in the trough off the Pacific coast.

Moderation occurred in California from the record October warmth, principally late in the month as the trough moved inland. Some cooling in the Northern Plains reflected the influence of a surface ridge extending southward from the eastern Canadian blocking High. Cool weather also prevailed in New England from the northerly flow associated with cyclonic activity centered just to the northeast.

In Alaska, temperatures rose sharply in the northwestern portion, averaging 14° F. above normal at Barrow, as a consequence of southwesterly flow and above normal heights in the blocking ridge. On the other hand, Juneau, in the southeastern portion, averaged 4° F. below normal in response to abnormal northeasterly components of flow on the east side of the ridge.

Elsewhere in the hemisphere, temperatures were far below normal in northern Europe and Asia in the extensive zone of below normal heights at 700 mb. (fig. 2). In Britain, and in Germany, temperatures averaged as much as 4.3° F. below normal, and across the USSR, as much as 5.5° F. below normal eastward to the Sea of Okhotsk. South of the jet axis (fig. 3) in Europe and Asia above normal temperatures were in sharp contrast to the cold weather farther north as mild Atlantic air masses were swept across the continent by the strong westerlies.

4. PRECIPITATION

Precipitation was above normal in the western United States (fig. 5) in agreement with the prevailing southwesterly flow west of the ridge in the average circulation (fig. 1). However, the Southwest received greater totals, compared to the normal, than anywhere in the country because of the strong orographic lifting of warm, moist air up the slopes of the Sierras. Rainfall exceeded eight times the normal in parts of southern California. Total amounts in excess of 8 in. occurred along the Oregon coast where the normal is many times greater than in southern California.

The rains in the Southwest, and indeed the large-scale circulation and United States temperature regime as well, were reminiscent of a similar situation in April 1965 [3]. In both months blocking positive height anomalies in the North Pacific maintained deep troughs and negative height anomalies off the California coast. In November 1965, the cyclonically curved geostrophic flow implied by the height anomaly contour gradient along the southern California coast was stronger (fig. 2) than in April. Rainfall was also greater.

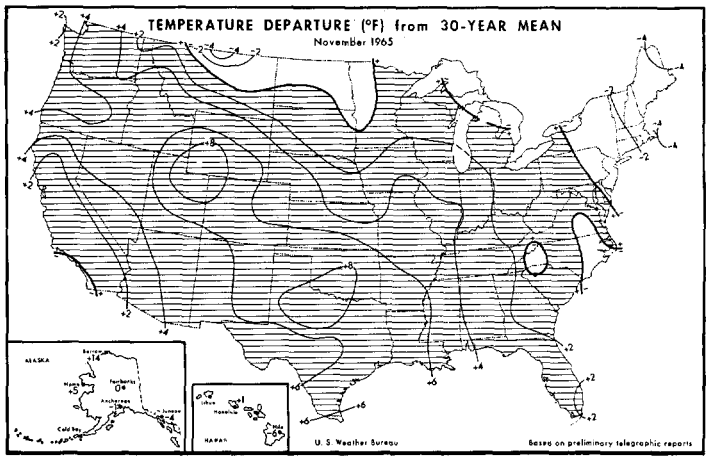


FIGURE 4.—Surface temperature departure from normal (°F.), November 1965. (From [5].)

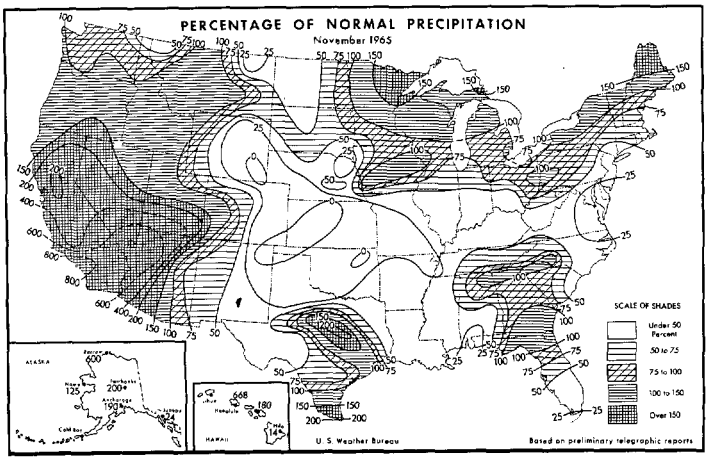


FIGURE 5.—Percentage of normal precipitation, November 1965. (From [5].)

In Hawaii, most of the record rainfall of 14.72 in. at Honolulu fell in the second week and was associated with the deep trough west of the Islands. This produced strong southwesterly winds aloft for several days (see fig. 7 A and B), during which several surface Lows developed south of the Islands.

Most regions east of the Rockies received subnormal precipitation from the prevailing northwesterly flow which was dessicated by both topographic and dynamic subsidence, and the lack of cold air for overrunning except in the extreme north. The enhanced subsidence in the Central Plains may be inferred from the anticyclonic height anomaly contours in figure 2. The extreme dryness in the Middle Atlantic States is also suggested in the same way, but probably more important was the trough location off the coast instead of near its usual November position in the Midwest [1]. The long drought in northern New York and New England was alleviated slightly, but the extreme dryness farther south further aggravated the severe 4-year drought in the remainder of the Middle Atlantic region and southern New England. In these areas there has been no substantial rainfall since early October.

5. WEEKLY WEATHER RELATED TO THE CIRCULATION

NOVEMBER 1–7

Deep troughs off both coasts and strong ridges in the United States and the Atlantic prevailed during the first week (fig. 6A). Heights as much as 340 ft. above normal in the American ridge (fig. 6B) favored a storm track across southern Canada and the spread of warm air over all regions except the Northeast (fig. 6C). Two bursts of warming advanced eastward from the northern Rockies on November 1 and 4 when temperatures reached 20° F. and 18° F. above normal, respectively, at Great Falls, Mont. Record readings (74° F.) for so late in the year occurred at Pendleton, Oreg., and Bismarck, N. Dak.

Heavy rains fell in the Pacific Northwest from disturbances out of the deep trough off the coast (fig. 6D). Heavy rains also fell in eastern Texas, Arkansas, and Louisiana on November 3–5 as a result of an upper disturbance.

NOVEMBER 8–14

Heights lowered sharply at 700 mb. over the country, accompanied by a westward shift of the trough location from off the Atlantic coast to the Mississippi River (fig. 7A). Blocking intensified in the North Atlantic and in the Pacific where heights increased to as much as 740 ft. and 800 ft., respectively, above normal (fig. 7B).

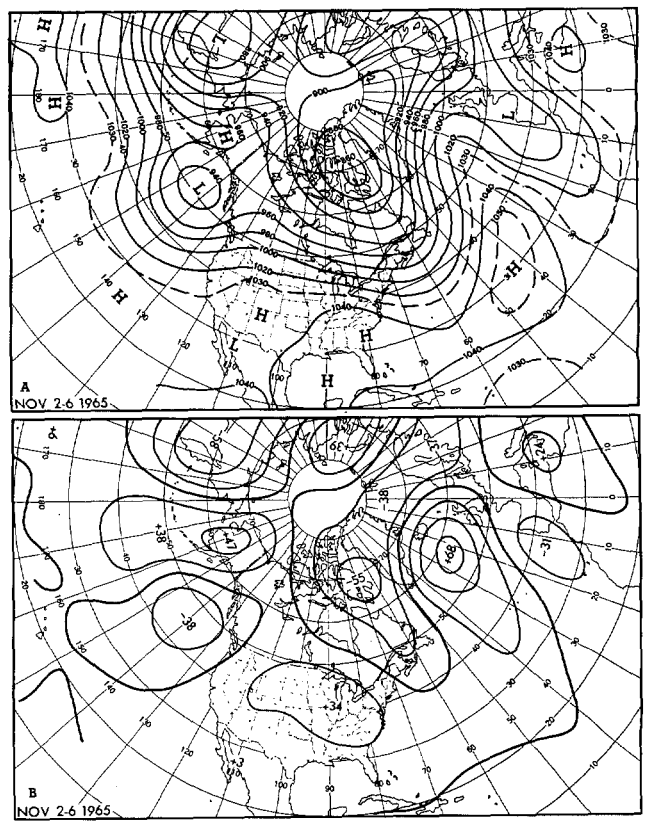
East of the Continental Divide, temperatures fell to below normal in the north as cold air from the Yukon spread across the Great Lakes on November 9 and 14. To the south, however, temperatures rose even higher this week (fig. 7C). In the Rockies temperatures reached 18° F. above normal on November 14 for the third consecutive week of warm weather in the strong southwesterly flow from the Pacific.

Moderate to heavy rains fell in the Pacific Northwest on November 8 and also from eastern Texas northward in advance of the first cool Canadian outbreak. On November 10, moderate to heavy rains fell in parts of the Southeast. Another storm from the Pacific Northwest spread heavy rains across the Northern States, and in many parts of the East on November 13 in advance of the second cool air outbreak from Canada. This followed an intense storm over the Great Lakes on November 12 which was accompanied by tornadoes in Illinois and Indiana and several inches of snow from Montana to Michigan.

In the Far West heavy rains continued after the 10th and spread southward into southern California on November 13 and 14 (fig. 7D) associated with the gradual southward migration of the Alaskan block and the deep storm center off the California coast.

NOVEMBER 15–21

The Alaskan blocking High settled southward over the North Pacific during this week, while the Iceland block shifted to Greenland (fig. 8A). Both blocks continued to intensify as 700-mb. heights reached 950 ft. above normal in the Pacific and over 1230 ft. above normal in



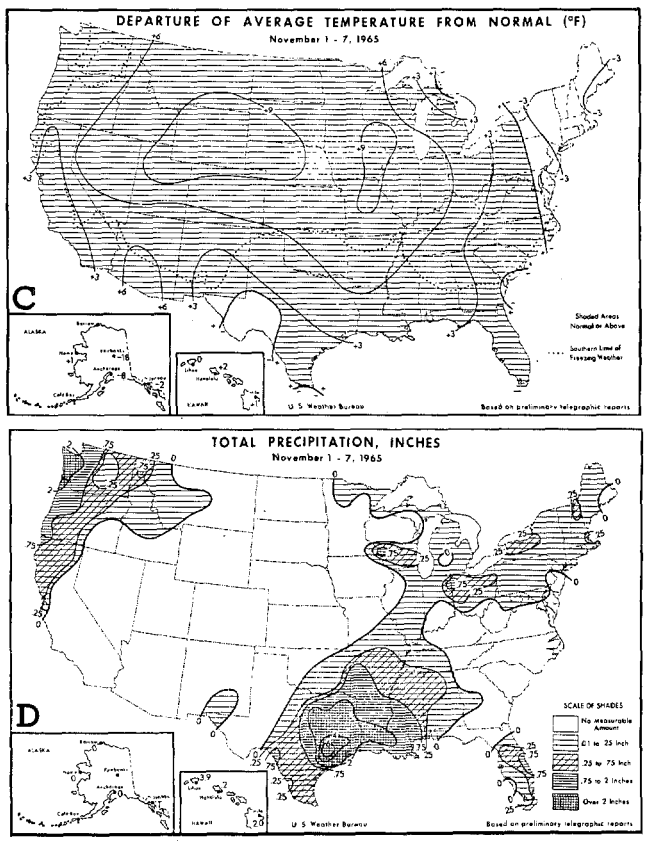
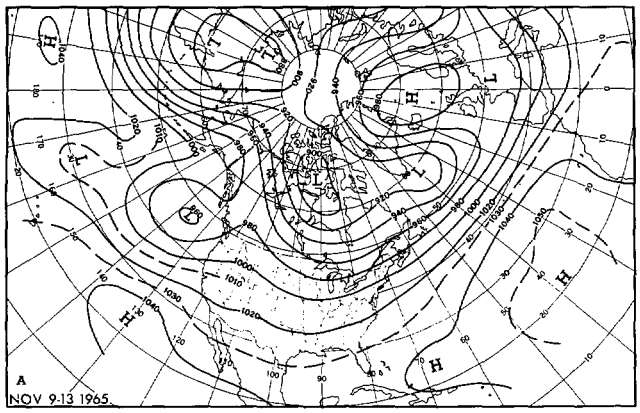
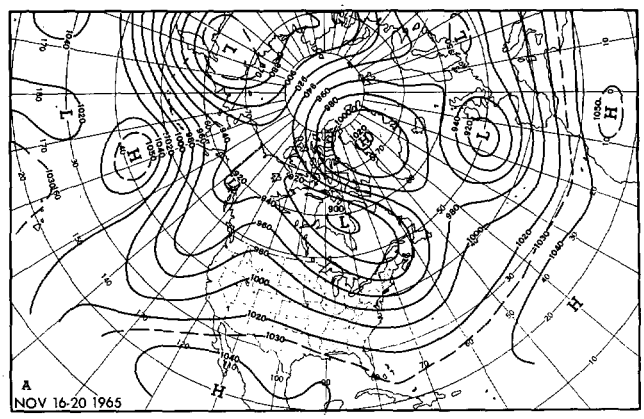
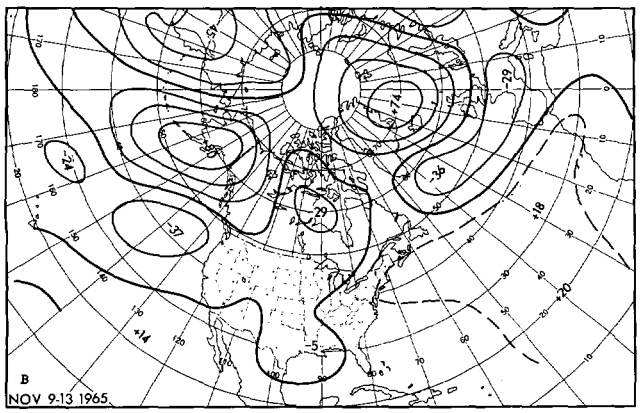
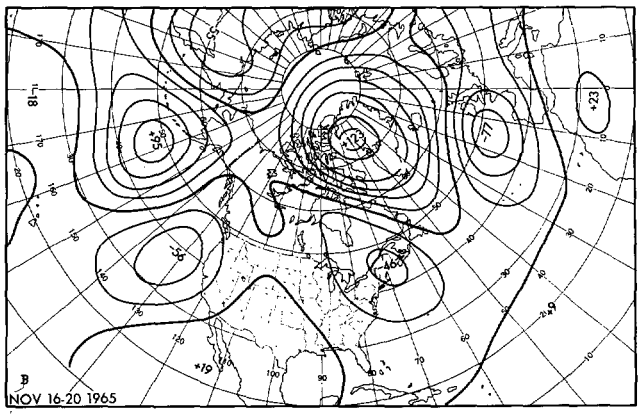


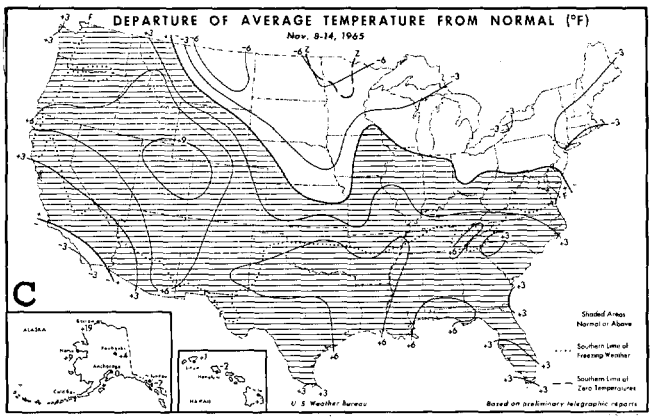
FIGURE 6.—Week of November 1–7, 1965: (A) 700-mb. contours and (B) departure from normal (both in tens of feet) for November 2–6. (C) Surface temperature departure from normal (°F.) and (D) total precipitation (in.) (from [5]).

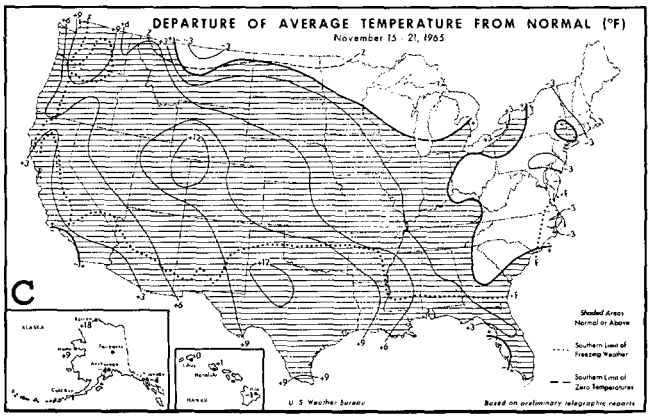


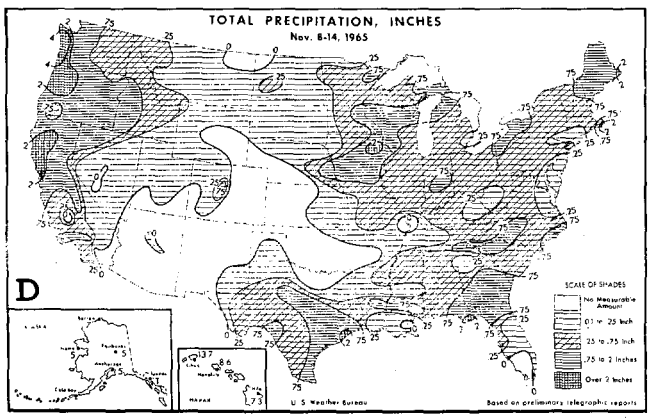












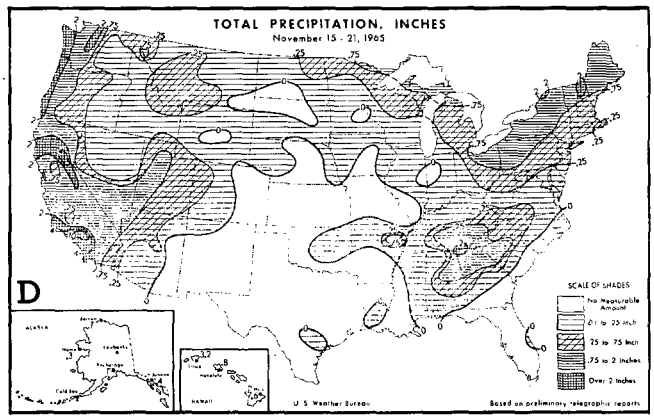
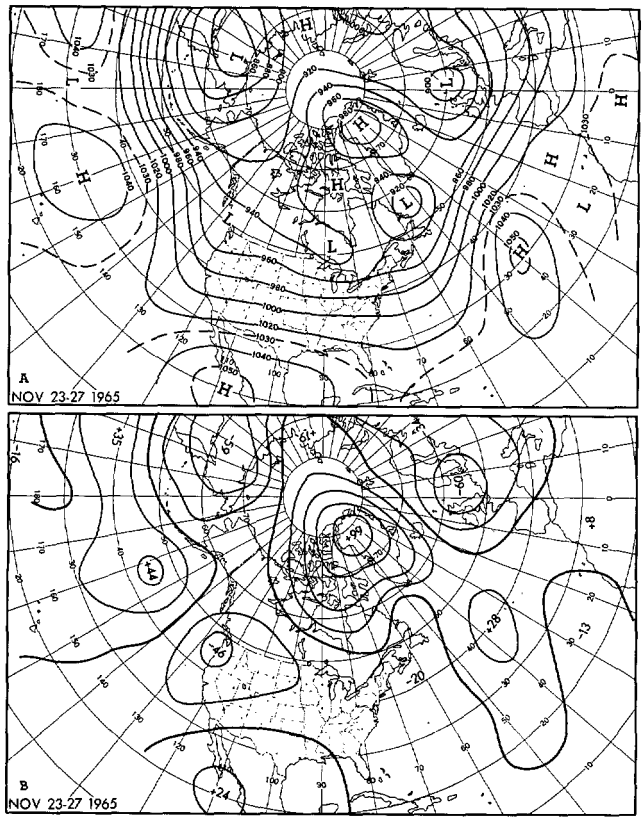


FIGURE 7.—Week of November 8–14, 1965: (A) 700-mb. contours and (B) departure from normal for November 9–13. (C) and (D) as in figure 6.

FIGURE 8.—Week of November 15–21, 1965: (A) 700-mb. contours and (B) departure from normal for November 16–20. (C) and (D) as in figure 6.



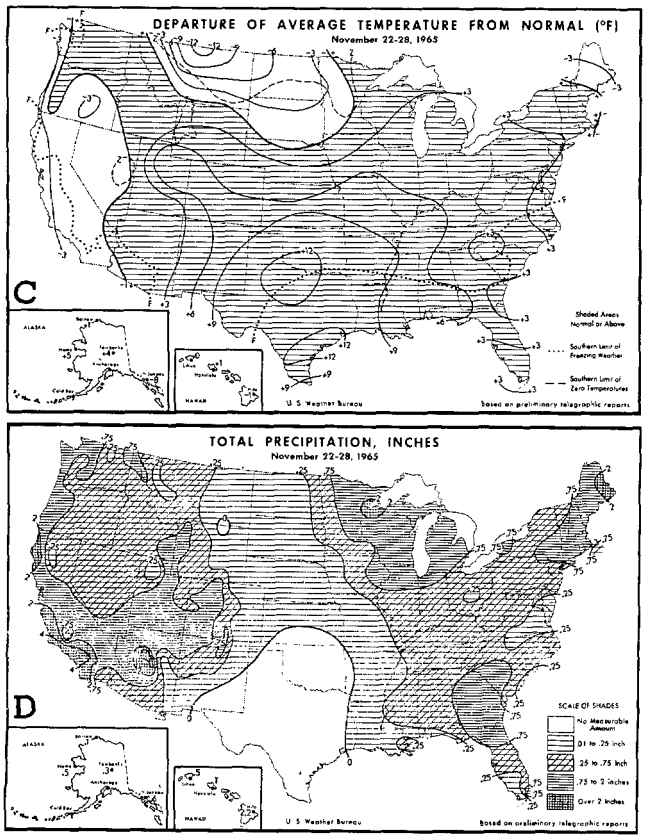


FIGURE 9.—Week of November 22–28, 1965: (A) 700-mb. contours and (B) departure from normal for November 23–27. (C) and (D) as in figure 6.

the Greenland region (fig. 8B). The latter anomaly was as high as has ever been observed in this region.

Much stronger than normal southwesterly flow east of the deep Low off the California coast resulted in the warmest period of the month and the fourth consecutive warm week in the Rockies (fig. 8C). On November 15, temperatures averaged 23° F. above normal at Amarillo, Tex., and on November 18 were 17° F. above normal at Salt Lake City, Utah. Another cold outbreak spread from Montana on November 16 to the Eastern States two days later.

Heavy rains continued over much of the Far West from November 15 to 18 and very heavy rains fell in southern California in association with the abnormal intensity and southerly position of the storm center off the coast (fig. 8D). Los Angeles measured 4.3 in. in a 4-day period, the wettest such period for any season since 1900, and 5.3 in. for the week. Nearby Mt. Wilson reported about 16 in. for the week's total. Substantial damage resulted from floods and mudslides.

Across the northern tier of States a deep storm on November 15–18 brought heavy precipitation, including up to a foot of snow, to parts of the Upper Mississippi Valley and the Northeast. Winds gusted to 50 m.p.h., and at least six tornadoes were responsible for two fatalities in Ohio. On November 21, a developing Low moved northeastward across the Tennessee Valley accompanied by heavy rains, including 3.14 in. at Chattanooga, Tenn.

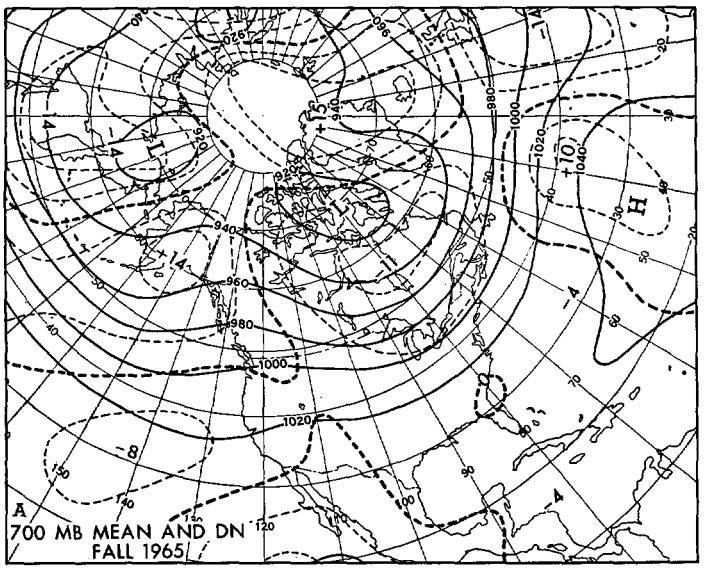
NOVEMBER 22–30

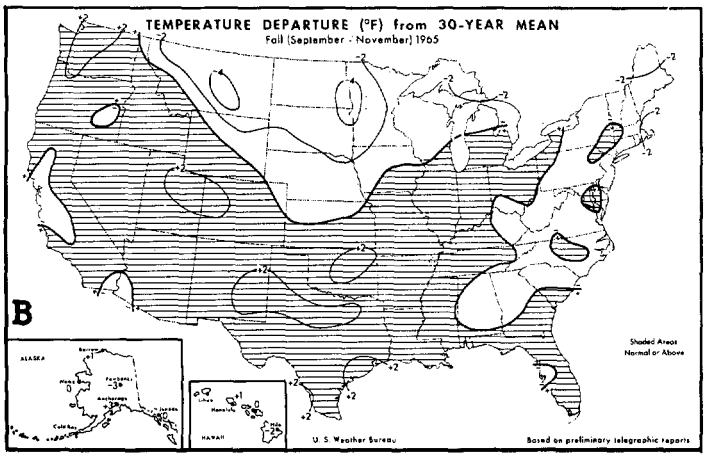
During this period the eastern Pacific trough moved onshore and the entire Nation came under the influence of fast westerlies south of normal (fig. 9A). This was linked to weakening of the Pacific blocking High to 440 ft. above normal (fig. 9B). The Greenland block also weakened but spread southward, shifting the storm track to the central United States.

The shift of the Pacific trough inland produced general cooling in the Western and North Central States during the week (fig. 9C), while the Southern Plains to the Atlantic coast remained warm except for the last few days of the month. On Thanksgiving Day, the temperature was as much as 24° F. above normal in northern Texas. November 26 was the warmest day so late in the year from Texas to the Ohio Valley with representative temperatures of 86° F. at Dallas and 78° F. at Evansville, Ind.

On November 22 moderate to heavy rains fell in the East, while heavy rains returned to southern California and the adjacent Southwest. Los Angeles received an additional 3.5 in., bringing the total to 9.34 in. in less than two weeks. In the mountains another 15 in. of rain caused heavy damage from flooding and mudslides. Heavy snow blocked passes in the Sierras.

Rain or snow spread inland over most of the Rocky Mountain States; Elko, Nev., received a record 24-hr. snowfall of 9 in. on November 23 and 24, and Flagstaff,





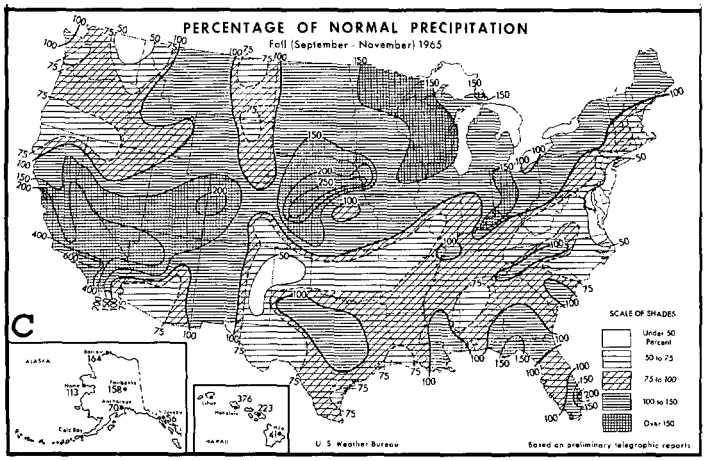


FIGURE 10.—Conditions in fall 1965: (A) Mean 700-mb. contours (solid) and height departures from normal (dashed) (both in tens of feet). (B) Surface temperature departure from normal (°F) (from [5]). (C) Percentage of normal precipitation, (from [5]).

Ariz., received more than 4 in. of rain in three days. As the upper trough moved inland a Southwest Low developed into a blizzard with winds up to 50 m.p.h. as it moved from Colorado to the upper Great Lakes on November 26, attaining a central pressure of about 974 mb. This severe storm brought heavy precipitation to the Midwest including a record 24-hr. snowfall for November of 14.7 in. to Duluth, Minn., on November 26, tornadoes to Illinois, Indiana, and Ohio, and heavy precipitation to the East on November 27. On November 28, Buffalo, N.Y., received its first heavy snowstorm of the season totaling 8.2 in. In the wake of this storm a wedge of cold air with temperatures as much as 19° F. below normal overspread the entire East on the last three days of the month. At the same time the entire country had a respite from any precipitation.

6. AVERAGE FALL WEATHER

The circulation for fall 1965 (fig. 10A) was a composite of eastward movement in the Pacific and retrogression in the North Atlantic and Europe. A deep trough in mid-Pacific in September [4] advanced to the coast of North America by the end of November, while the European ridge shifted westward to Greenland, culminating in amplification of the Alaskan and Greenland ridges. The net effect of this evolution was the tendency for the September anomalies to counteract those of October, resulting in a closer resemblance of the seasonal patterns with those of November than with the other months. This is reflected especially in the ridges and associated positive anomaly centers in Alaska and Greenland, and the negative anomaly between California and Hawaii.

The composite temperature regime in the fall (fig. 10B) largely represented an overcompensation of the abnormal cold in the western and central regions by the eastward progress of warm air in October and November, except in the Northern Plains where the September cold prevailed.

Precipitation averaged in the "heavy" category from the Southwest to the Upper Mississippi Valley (fig. 10C) as a result of the very heavy rains in September in North-Central regions and in November in the Southwest.

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